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Preparation and Evaluation of Precooked, Dehydrated Bean Products^a

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IN THE PAST, DEHYDRATION has provided the Military Services with a means for the preservation of foods which has permitted significant savings in storage and transportation requirements. However, at the present time, the impact of radical new weapons on organizational, tactical, and logistical planning demands that new concepts of military feeding be utilized. Now, combat troops must have maximum mobility and dispersion for varied lengths of time. In order to obtain the mobility desired, it becomes necessary to reduce materiel transport to the minimum. Presently available dehydrated foods only partially satisfy this heightened requirement, and it has been necessary to attempt modifications aimed at minimizing equipment and personnel needs.

Precooked, dehydrated foods, which can be prepared by the simple addition of hot water (190°-200° F.) with no added cooking, appear to offer the means for reducing the demands for specially trained food service personnel and for special preparation and serving equipment.

A satisfactory method for dehydrating baked beans was described by Esselen and Davis (3), in 1942. However, the product described was produced from baked beans with sauce (a 5 to 6 hour process) and a dehydration schedule of 8 to 10 hours at 140° F. This item was rehydrated by soaking for 1½ hours, followed by a short heating time. This type of product, although acceptable at that time, would not satisfy the present need for food items which would rehydrate in 5 to 10 minutes without additional cooking.

MATERIALS AND METHODS

The Michigan Pea (Navy) variety of dried beans was selected for intensive study since it is a variety normally used in combination food dishes, and also because it was considered the most suitable for dehydration (3, 4).

The dry beans were washed and soaked for at least 8 hours (2) in water at a temperature of approximately 60° F. The soaked beans were then screened to remove those which had not swelled.

A range of initial pre-cooking conditions was established:

1. Atmospheric boiling schedules at 212° F. for periods of 30 to 160 minutes,
2. Pressure steam cooking schedules at 245° F. 13 p.s.i. for periods of 10 to 30 minutes.

The cooked beans were subjected to the following pretreatments before dehydration:

1. Control, i.e., no pretreatment,
2. Sugar dipping in 30° Brix sucrose solutions for periods of 1 to 15 minutes,
3. Freezing before dehydration, wherein the product was placed in the dehydrator in the frozen state.

Dehydration was conducted in a Proctor and Schwartz through-air-flow tray dehydrator utilizing a low humidity schedule.

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With this unit, dry bulb temperature could be controlled to $\pm 1^\circ$ F. Humidity was controlled by means of direct steam injection into the chamber in front of the blower fan.

Moisture contents of the materials used in this study were determined by the standard A.O.A.C. method in a vacuum oven for 6 hours (1).

The dehydrated product was evaluated visually with special emphasis on bursting, splitting, and acceptability as judged by over-all appearance.

The product was rehydrated in near boiling water (190°-200° F.) for 5 minutes and examined for completeness of rehydration, i.e., texture, appearance, flavor, and odor. The greatest emphasis was placed on the ability of the product to rehydrate in approximately 5 minutes; hence, this governed the rating of the other factors.

Rehydration ratios were determined as $\frac{W_r}{W_d}$, where W_d is the weight of dehydrated product and W_r is the weight of the rehydrated product (6). In addition, these products were evaluated to determine their ability to rehydrate in combination with other dehydrated items.

RESULTS AND DISCUSSION

A. Cooking

1. *Atmospheric boiling.* At least 105 minutes were necessary to obtain a completely cooked, mealy textured bean. This length of time appreciably lengthened the processing cycle and was deemed unacceptable for maximum production capacity or efficiency.

2. *Steam pressure cooking.* In the range of 10 to 30 minutes cook at 245° F., 13 p.s.i., the 20-minute process gave the most satisfactory texture characteristics. A longer cook rendered the product mushy; a shorter cook resulted in graininess.

B. Pretreatments

1. *Sugar dipping.* A 30° Brix sugar solution dip for 1, 5, 10, and 15 minutes lessened the degree of bursting to 30-75% after 1½ hours dehydration at 130° F. The control samples, on the other hand, exhibited 80-100% bursting. Although the sugar dip lessened the bursting effect, the samples were hard and grainy upon rehydration.

2. *Freezing.* Prefreezing minimizes bursting during dehydration at all temperatures of the low humidity schedule (Table 1). The over-all appearance of the prefrozen dehydrated products was excellent. (Figures 1 and 2).

TABLE 1
Low humidity schedule

| Dry Bulb ° F. | Wet Bulb ° F. |
|---------------|---------------|
| 130 | 78 |
| 150 | 84 |
| 170 | 88 |
| 190 | 94 |

C. Dehydration

1. The low humidity dehydration schedules produced an acceptable bean only when the prefreezing treatment was used (Table 1). In this case, as noted previously,

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a highly acceptable product was the result. The 170° F. dry bulb and 190° F. dry bulb prefrozen runs were judged to have produced the best rehydrating beans. However, the other prefrozen runs produced beans which were only slightly less acceptable.

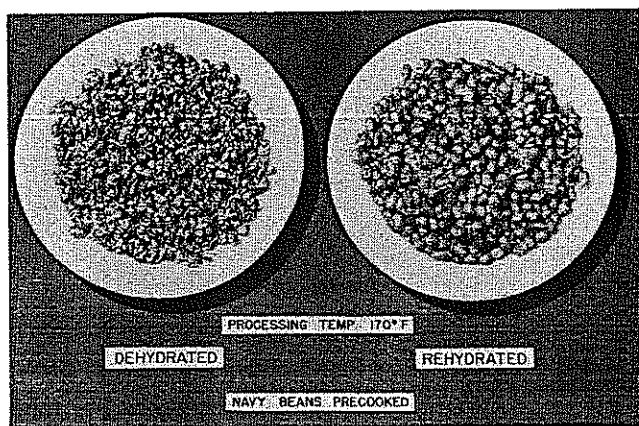


Figure 1

2. The dehydration cycles of the prefrozen beans were shorter than those of the non-frozen beans (see Figure 3) to reach a safe moisture level of less than 4% (5).

3. Recognizing that the introduction of freezing would increase the cost and complicate the process, a high humidity schedule was investigated to determine whether bursting could be controlled. At 170° F. dry bulb and 150-156° F. wet bulb for 1½ hours followed by progressively decreasing humidity until 88° F. wet bulb was reached, the bursting effect was lessened but a more dense bean was produced. Rehydration of this material resulted in a grainy product even after 10 minutes. More work is being carried out using high humidity conditions to determine whether longer cooks and lower initial dehydration temperatures will produce a good bean product.

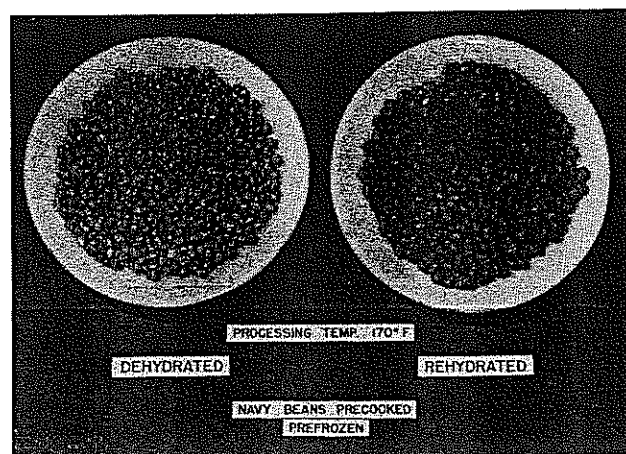


Figure 2

D. Rehydration

1. The samples were covered with near boiling water (190° F.-200° F.) and allowed to stand for at least 5 minutes. The product was judged to be completely

DRYING CHARACTERISTICS OF NAVY BEANS

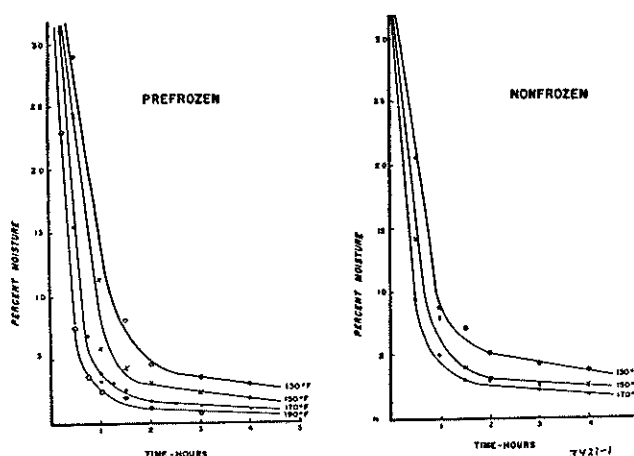


Figure 3

TABLE 2
Selection of treatment schedules

| Run No. | Cooking | Pretreatment | Drying | Texture |
|---------|--|--|--|--|
| 1 | Atmospheric Boiling 105 minutes | | | Mealy |
| 2 | a. 245° F. 13 p.s.i. 10 minutes b. 15 minutes c. 20 minutes d. 30 minutes | | | a. grainy b. grainy c. mealy d. mushy |
| 3 | a. 245° F. 13 p.s.i. 20 minutes b. c. d. | 30° Brix sugar dip 1 min. 5 min. 10 min. 15 min. | 130° F. 1½ hours | hard and grainy. Bursting decreased by 30-75% |
| 4 | a. 245° F. 13 p.s.i. 20 minutes b. c. | No Freezing | 130° F. 4 hours 150° F. 4 hours 170° F. 4 hours less than 10% R.H. | Excessive splitting and mushy |
| 5 | a. 245° F. 13 p.s.i. 20 minutes b. c. d. | Freezing | 130° F. 4 hours 150° F. 4 hours 170° F. 4 hours 190° F. 4 hours less than 10% R.H. | a. grainy b. grainy c. mealy d. mealy |

rehydrated when it had assumed a whole bean shape and mealy texture. In the acceptable samples, an average rehydration ratio of 2.5:1 was obtained.

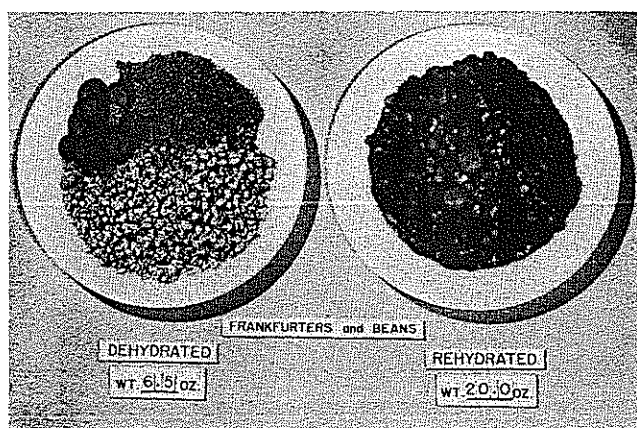


Figure 4

E. Other varieties

1. Once the optimum conditions had been determined for Michigan Pea Beans, exploratory work was conducted on other varieties. California Pea and Great Northern beans also yield acceptable products when processed as stated above. An acceptable Red Kidney bean precooked product can be produced by subjecting the soaked beans to pressure steam cooking for 15 minutes at 245° F., 13 p.s.i., prefreezing, and then dehydrating at 130° F. dry bulb and 78° F. wet bulb (see Table 1) for a sufficient length of time to reach a safe moisture level of less than 4%.

F. Combination items

1. Precooked, dehydrated Michigan Pea beans may be formulated into Beans and Tomato Sauce or Beans, Franks and Tomato Sauce using all dry or dehydrated ingredients, i.e., tomato powder, spices, sugar, salt, and precooked, freeze dried frankfurters (Figure 4). Precooked, dehydrated California Pea or Great Northern beans may be substituted in the above combinations.

2. Precooked, dehydrated Red Kidney beans may be mixed with precooked, freeze-dried hamburger, tomato powder, chili powder, and seasonings to give a

completely precooked chili con carne. Without the hamburger it becomes a meatless chili dish.

3. The meat combination dishes require 10 minutes for rehydration in near boiling water since the meat items are limited in rehydration rate.

Future work. Additional studies will be conducted to determine whether high humidity drying can be used to replace the pre-freeze treatment.

Storage studies have been initiated to obtain storage stability data for the various bean products and combination dishes enumerated herein.

SUMMARY

The effects of certain variables on the production of precooked, dehydrated bean products are given. An acceptable precooked, dehydrated bean product was produced on a laboratory scale using dry Michigan Pea beans (Navy). The beans were soaked for at least 8 hours followed by steam pressure cooking at 245° F., 13 p.s.i. for 20 minutes; the cooked beans were then frozen and dehydrated at either 170° F. dry bulb, 88° F. wet bulb (Figure 2) or 190° F. dry bulb, 94° F. wet bulb for 1½ or 1¼ hours, respectively. Great Northern and California Pea beans may also be dehydrated using these conditions, but Red Kidney beans require a shorter cook and lower dehydration temperature.

Acknowledgments

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